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June 9, 2003

Mr. Nabil S. Fayoumi
U. S. Environmental Protection Agency - Region 5
Superfund Division
77 West Jackson Boulevard (SR-6J)
Chicago, Illinois 60604-3590

Re: Response to Comments on Implementation Of Slurry Wall Construction Groundwater Migration Control System Sauget Area 2 – Sites O, Q, R And S Sauget, Illinois

Dear Mr. Fayoumi:

This letter responds to comments provided by you in an e-mail message dated May 15, 2003. Separate comments were prepared by CH2M Hill and by the U. S. EPA Applied Research and Technical Support Branch. Both sets of comments were based on a review of a technical memorandum submitted by Solutia that discussed the use of a conventional soil-bentonite slurry wall instead of a jet grouted wall at the referenced site. For ease of reference, each of the comments is reproduced below in italicized text, immediately followed by our response to that comment.

Comments by CH2M Hill

Comment 1:

Slurry wall technology has evolved to the point where an experienced contractor with the right equipment can construct a slurry wall to the depths required for this project. A contractor such as Inquip or another organization with comparable experience, expertise, and equipment should be able to construct this project as outlined.

The soil conditions are generally favorable for a slurry wall, although caution will have to be exercised as the trench bottom approaches the top of the bedrock due to the downward-coarsening trend of the grain size. This can be managed by careful monitoring of slurry loss, using a slurry that is viscous enough to prevent sudden loss ("blow-out") into the gravels, and having a contingency plan to provide for rapid backfilling of the lower portion of the trench should blow-out begin. The slurry mix can then be adjusted before excavation continues.

One caution relates to the proposal to complete the slurry wall "directly on top of the rock." My experience in the St. Louis area is that a layer of insoluble chert often occurs at the top of limestone or dolomite bedrock. This chert layer is formed as the limestone *or dolomite weather, leaving a layer of the relatively insoluble chert nodules that are typically found in the limestones and dolomites in the St. Louis area. In addition, the top of bedrock can be irregular in shape and depth, sometimes with weathered joints that can be several inches or more wide near the top of bedrock, and may extend many feet deep. Finally, the coarsest material will settle out of the slurry first and accumulate on the bottom of the trench. All of these factors together suggest the potential for a permeable zone at the bottom of the slurry trench unless particular care is taken to thoroughly clean the trench bottom.*

The three boring logs reviewed indicate at least some weathered limestone at the top of bedrock in each boring. The powered clamshell should easily be able to penetrate a short distance into this material. We suggest that the specifications be written to require trench bottom cleaning with the clamshell or comparable equipment until the material brought up consists primarily (i.e., more than half) of weathered limestone fragments. This would eliminate the need to perform rock excavation, coring, and repeated measurements to verify formation of a true "key trench," but would result in thorough trench bottom cleaning that should provide a reasonably good seal to most of the bedrock. This would also address the most weathered material around the top of joints as this material would be removed with this cleaning approach. Some weathered joints would probably remain, but as pointed out in the April 24 document, these joints would not have been treated by jet grouting either.

Response:

We agree with this comment. As noted in Section 3 and Attachment A of the technical memorandum, it is our intention to use the clamshell bucket to thoroughly clean the top of rock and to ensure that the slurry trench will be in intimate contact with the top of rock.

Comment 2:

Finally, we note that the last bullet on page 6 of the April 24 document implies that groundwater levels after installation of the barrier will be maintained at a zero gradient. It is suggested that a small inward gradient be maintained once the wall is placed in service. A small inward gradient will limit the potential for offsite contaminant migration; should flow occur, it would be clean water flowing into the site rather than contaminated water flowing out of the site. Also, since gradients can only be measured at discrete locations, maintaining a small inward gradient at those monitoring points helps reduce the potential that unobserved outward gradients might occur at locations between monitoring points. Further, small errors in water level measurements and small survey errors make verification of a true "zero gradient" difficult. We suggest that a small inward gradient, on the order of at least 2 to 6 inches, be maintained. The minimum gradient should be selected once the wall is in place, and should be based on factors such as the range of observed water levels, monitoring point spacing, the observed variation in water levels between adjacent monitoring wells, and similar factors.

Response:

Use of a zero gradient condition across the wall as a measure of wall performance is specified in the Record of Decision (ROD). The ROD says, in part (page 58):

> "Pumping rates will be adjusted so that the water-level elevation in the inside piezometer is the same as the water-level elevation in the outside piezometer. This will ensure that groundwater moving to the physical barrier is controlled."

In order to evaluate the impact of maintaining a small inward gradient, additional modeling was carried out to determine the increase in the groundwater extraction rate that would be required to maintain 2, 4, and 6 inch inward heads across the wall. The analyses indicate that the average groundwater extraction rate would have to be increased by almost 60 percent (to 842 gpm from 535 gpm) in order to maintain a 2 inch inward head differential. Extraction rates would have to increase to 882 gpm and 992 gpm to maintain inward head differentials of 4 and 6 inches respectively. Increasing the average pumping rate to 842 gpm to maintain a 2 inch inward head differential will result in an increase of approximately $810,00 in the annual operating cost of the system. The increase in annual operating costs to maintain a 6 inch head differential is approximately $1,300,000.

Recognizing that the extraction system is designed to remove the same volume of groundwater as the steady state flow into the wall, it is reasonable to expect that any head imbalance across the wall will be very small and will be localized. Given that the hydraulic conductivity of the wall is expected to be in the range of 1×10^{-7} cm/sec., the seepage through the wall resulting from such small localized gradients will be minor. Consequently, the expenditure of such large annual sums of money for minimal or no benefit is not justified.

Comments by U. S. EPA Applied Research and Technical Support Branch

Comment 1

The overall effectiveness of the physical barrier will likely be dependant on a number of factors including the extent to which the bedrock is fractured and the resulting hydraulic gradient across the wall. While it may be true that "the amount of groundwater flow through weathered or fractured bedrock is likely to be a very small fraction of the flow in the alluvial aquifer" under existing conditions, as stated in the Focused Feasibility Study, this may change once a vertical barrier is installed. Depending on the hydraulic properties of the rock immediately below the wall, flow below the vertical barrier through the fractured bedrock may become an important issue if significant hydraulic gradients are allowed to develop across the barrier at this depth. Both of the proposed technologies (jet grouting and slurry wall) may suffer from the same limitations with respect to groundwater flow through the bedrock. It is recommended that the monitoring system include piezometers installed in the fractured/weathered bedrock to monitor the hydraulic gradient that develops across the wall.

Response:

As the commenter acknowledges:

> "Both of the proposed technologies (jet grouting and slurry wall) may suffer from the same limitations with respect to groundwater flow through the bedrock."

The purpose of the evaluation presented in the technical memorandum was to compare the behavior of a soil-bentonite slurry wall and a jet grouted wall. In that context, both systems will function equally well and, in consequence, the slurry wall can be used instead of a jet grouted wall without any decrease in performance. It should be recognized that the analyses reported in the Focused Feasibility Study were predicated on the presence of a wall. Those analyses showed that the system would capture the steady state flow into the wall enclosure, thus minimizing the potential for any underflow of the vertical barrier through the rock. This potential underflow will be even further reduced by the measures taken to ensure good contact between the wall and the top of rock, as recommended by CH2M Hill.

Finally, the following points should also be noted:

- The principal groundwater control measure is the extraction system, not the barrier wall. One purpose of the wall is to reduce the volume of extracted groundwater required to mitigate impacts on the river.

- The monitoring system for the barrier wall discussed in the technical memorandum was specified in the ROD.

Please review the these responses and let us know if you have any further comments or require additional information.

Sincerely,

Solutia Inc.

Steven D. Smith
Project Coordinator

cc: Sandra Bron - IEPA
Steven Acree – USEPA
Ken Bardo - USEPA
Mike Coffey - USF&W
Tim Gouger – USACE
Peter Barrett – CH2M Hill
Michael Henry - IDNR
Linda Tape - Husch & Eppenberger
Gary Vandiver - Solutia
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